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(54) **Adsorbent coatings for pollutants**

(57) An adsorbent material for combating the emission of odorants and/or pollutants is described which comprises a flat support material which forms a water-vapour permeable barrier layer and a layer located on said support material, containing adsorbent particles. A barrier layer covering the adsorbent particle-containing layer may be included. The source of the odorants or pollutants is directly covered with the material containing adsorbent particles, with the adsorbent particle-containing layer between source and the water-vapour permeable barrier layer.

The material may be in the form of wallpaper, textile fabrics or carpets for covering walls or floors or in the form of adhesive sealing strips.

Activated carbon is a preferred adsorbent and pollutants may be PCBs or radon.

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MATERIALS FOR THE DECONTAMINATION  
OF POLLUTED AREAS

The invention relates to suitable materials for combating the emission of odorants and pollutants, in particular to a method of decontaminating polluted rooms.

With increasing environmental consciousness and highly sensitive analytical methods, the public is becoming more aware of the environmental impact caused by harmful matter. There exists an increasing need for decontaminating buildings polluted by harmful matter (pollutants) or odorants with as little expenditure as possible. Furthermore, the need is recognized for means for simply determining the presence of harmful matter to allow consideration of the necessity for, and eventual success of, rehabilitation. The expression "harmful matter" or "pollutant", as used in this context, embraces substances that can cause irritations, allergies and illnesses in humans, even when present in small amounts. This includes, for example, wood preservatives, such as pentachlorophenol (PCP) and lindane, plasticizers, such as polychlorinated biphenyl (PCB) and also formaldehyde. The latter was used in chipboards and is now suspected to be carcinogenic. In addition it includes hydrocarbons, which may also be aromatic, and their chlorinated derivatives which can escape from, for example lacquers, paints or adhesives.

Particularly problematic substances are PCBs, which were used as plasticizers in joint sealants, especially in the construction of buildings from prefabricated elements. New findings have shown that with time the PCBs diffuse from the sealant into adjacent concrete elements and are

also liberated from the sealant into the ambient air. The PCB-polluted air may be distributed over the entire building via air circulation. The PCBs thus liberated from the joint packings, the so-called primary sources, settle in rooms, partly bonded to small parties but also dissolved to a large extent in wall paints and plastic materials. The result is that after some time, a number of so-called secondary emission sources are formed, in particular painted wall and ceiling surfaces. These secondary sources contain in general such a large amount of PCBs and constitute such large emission surfaces that the mere removal of the joint filling agents cannot reduce the concentration in the ambient air below maximum safety values.

A further source of harmful matter and odorants in carpeting. Emissions are produced as a result of the fact that, for example, the starting materials of these products react under the influence of moisture and/or the influence of components of the base material. The floor emits odorants and harmful matter even after the removal of the flooring material and thus necessitates either the removal of the entire flooring or the laying a false floor with bottom ventilation.

A further source of unpleasant emissions, which are sometimes detrimental to the health, are additives in the building material itself. For example, lots of buildings are contaminated with ammonia emissions originating from the use of ammonium salts, urea or organic amines, in a

broad sense, as anti-freezing compounds for concrete and mortar. Furthermore, another reason for the emission of amines may be the previous use of a room, for example for purposes of livestock husbandry, causing harmful matter to settle on building elements over a long period of time. If the sources of these substances are removed, for example if a stable is converted into a living room or an office, the substances will be emitted from the secondary sources i.e., walls and ceiling surfaces. This situation is comparable to the above-mentioned problem of PCB pollution, both in respect of its cause and effect.

German Patent Application 3818993 teaches a method of decontaminating polluted rooms. However, in this case, the polluted ambient air is purified. This is done by passing air over adsorbents, either by forced or natural circulation. For example, the polluted air is pressed through adsorption towers loaded with adsorbents. Another possibility described therein consists in passing the air over large surfaces loaded with adsorbents, such as curtains. However, a decisive disadvantage of this method is that it is only effective in respect of the polluted ambient air. The result is that the purified air is repeatedly mixed with the polluted air so that, at best, a dilution effect is achieved.

A possibility of disposal of harmful matter-containing joint sealants is described in German Patent Application 4028434. By applying appropriate measures, the sealant, i.e. the primary source, is cut off and disposed of.

However, the method is effective only in respect of the primary source. As already described above, the harmful matter from the secondary sources, i.e. the wall and ceiling surfaces, may also pollute the ambient air to a critical extent; the secondary sources cannot be decontaminated with this above-mentioned method.

A method of decontaminating polluted rooms is the subject of Great Britain Patent Application No. 9418767.1 of which the present Application is a divisional.

In accordance with one aspect of the present invention there is provided an adsorbent material comprising a flat support material which forms a water-vapour permeable barrier layer and a layer located on said support material, containing adsorbent particles.

In accordance with another aspect of the present invention there is provided an adsorbent material comprising a layer of flat support material, a water-vapour permeable barrier layer located on said support material and a layer containing adsorbent particles deposited on said barrier layer.

The adsorbent material is preferably used in the method of Great Britain Patent Application No. 9418767.1 which is characterised in that the emission source is directly covered with the material containing adsorbent particles. The main advantage of the method is that the penetration of the pollutants through the material and hence a transfer of the latter to the ambient air is prevented. By decontaminating the polluted emission

sources, the method acts a step earlier than the prior art methods. Thus, the method inhibits the transfer of the pollutants to the ambient air and the formation of secondary emission sources right from the beginning, whereas all the hitherto described methods are based on the measure of removing harmful matter from the polluted ambient air.

The covering of the emission source has two decisive advantages: harmful matter is not transmitted to the environment and the adsorption takes place where the concentration of noxious matter is highest.

By virtue of the method, the radon concentration in inhabited buildings can be reduced to such an extent that maximum threshold values, serving a precautionary measure for protection of public health, can be met.

Elements or articles adjacent to the primary emission sources may additionally be covered with the adsorbent material containing adsorbent particles. This covering is intended to inhibit the escape of harmful matter entailed by the diffusion of the pollutants from the primary emission sources into said adjacent elements and, in case of migration to the surface of said elements, their escape into the ambient air.

Preferably, the adsorbent material furthermore contains an additional cover layer deposited on said layer containing the adsorbent particles.

The function of the barrier layer is to increase the contact time between the harmful matter and the adsorbents

by retarding the migration rate of the harmful matter from the emission source towards the surface of the composite material. A further advantage of the barrier layer is to inhibit the migration of non-readily volatilized permanently absorbable gases from the ambient air into the adsorption layer which would otherwise reduce the adsorption capacity, e.g. radon escaping from the wall. It is preferably applied when porous air-permeable flat-shaped fabrics are used as supports. A support layer of the water vapour-permeable kind is appropriate in order not to prevent "breathing" of the surface to which the adsorbent material is applied.

The barrier layer can at the same time be the adhesive composition for the adsorbent particles. Moreover, the barrier layer can consist of a slit film laminated on the inner surface of the composite material's outer layer, preferably a fusion adhesive-slit film, which is connected to the adsorbent particles on the other side. In a further embodiment, the barrier layer may consist of a latex coating or a latex paint applied on the outer surface of the composite material facing towards the area to be decontaminated.

The use of a fusion adhesive-slit film as the barrier layer, by means of which the outer layer is laminated on the adsorption layer, has proved to be very efficient for the adsorption of radon. Depending on the laminating temperature, the penetration of air is reduced by about 90% while at the same time the radon adsorption is basically

improved. The moisture penetration is more than satisfactory and consequently a risk of accumulation of moisture in the walling does not exist. A specific method for radon adsorption is one where the backside of the outer material is provided with a water vapour-permeable coating which simultaneously serves as adhesive layer for the adsorbent particles or spherules. Thereafter, a cover is laminated on the adsorber layer obtained by the coating process. The cover may be, for example, a textile or a paper. In both of the above-mentioned cases, the radon first comes into contact with the adsorption layer. That portion of the radon which is not completely adsorbed hereby, runs into the barrier layer and is retarded thereby so that the adsorption process can continue.

In one further embodiment, the material is selected from the group consisting of open-pored foam materials, non-woven fabrics and inorganic binders. It is in particular an open-pored foam material, preferably a reticulated PU foam, having a thickness of from 0.5 to 5.0 mm and containing finely-ground adsorbent particulars and a binder. The material may alternatively consist of a non-woven fabric having a thickness of from 0.1 to 2.0 mm and containing the adsorbent particles and the binder.

According to a further embodiment, the material may be a coating, a cast, a sound absorbing cast or floor finish containing the adsorbent particles. Alternatively, the material containing the adsorbent particles may be wall-to-wall carpeting, preferably back-side coated carpeting.



The term binder or binding agent as used herein includes all substances which connect substances of the same kind or different substances to each other. Thus, in the case of a cast, they may be, for example, all non-liquid, liquid and potentially liquid binders (plaster stone, water glass, Sorel's cement, magnesia cement, white lime, hydraulic lime, cement, blast furnace slag etc.). In the case of the open-pored foam materials and non-woven fabrics, the binders are, for example, all natural or synthetic materials that are used as solutions, dispersions, molten masses or liquid reactive plastic systems after formation (for example, by suitable resins and plasticizers, occasionally also pigments and fillers) for bonding different kinds of materials.

As to the use of a cast or a floor finish those compositions have proved to be advantageous which simultaneously serve for sound-proofing. One reason for this behaviour might be the high porosity which at the same time allows a good accessibility to the adsorbent. The cast is usually delivered as dry mixture with up to 50% by weight of adsorbent particles and is prepared to form a paste prior to use. Likewise, a floor to be decontaminated can be covered with an additional floor finish containing up to 50% by weight adsorbent particles.

In a further embodiment the adsorbents may also be incorporated into a wallpaper paste. The adhesive can, for example, consist of a 40%-ethylacrylate dispersion to which 60% by weight of ground activated carbon forming a slurry

with water is added. Walls and ceilings can be coated with a layer having a thickness of 300 micrometers and a conventional wallpaper can be applied on this layer. The adhesion is good.

If one uses hydrophobic molecular sieves as adsorbents, a white ground shade is obtained to which any kind of colouring pigments can be added. An effective control of the thickness of the layer remains important to avoid local weak points due to insufficient amounts of adsorbents.

Instead of wallpaper paste, the adsorbents can also be incorporated into a paint, in which case this has to be applied sufficiently thickly. For reasons of outer appearance, activated carbon will generally not be used to this end but instead molecular sieves. Paints are useful especially when irregular and non-planar bodies (cables, tubes) or cuts are to be covered. In preparing materials, care should be taken that the binder does not contain substances that can be adsorbed by the adsorbent particles. The expert in this field knows suitable solutions that need not be further illustrated here. However, it is recommended to confirm the choice of binding agent by a blank test.

In a further embodiment, the material comprising the adsorbent particles is a wallpaper having applied thereon a reticulated 1.0 mm to 5.0 mm PU foam loaded with adsorbent particles. Foams of the kind are preferably squeezed with a mixture of ground activated carbon and a

dispersion of a binding agent and dried. In this case, a carbon loading of up to 200 g/m<sup>2</sup> may be achieved whilst, the binding agent/carbon ration of 1:1 to 1:5, based on the dry substance, may vary.

The term "wallpaper" as employed herein is intended to include all types of sheet form wall coverings whether made from paper or other materials whilst the term "paint" includes all types of surface coatings applied in liquid or spreadable form.

In a further embodiment the material containing the adsorbent particles is a support layer made of a flat support material selected from the group consisting of paper, wallpaper or textile fabrics, such as woven fabrics, knitted fabrics, non-woven fabrics or glass cloth, and the adsorbent particles are applied on this support layer. Preferably, this support layer forms, together with the particles applied thereon, a test strip which is deposited on covered or uncovered building elements to determine the penetration of pollutants through the covering or to determine the emission of exit of pollutants.

A suitable support material containing activated carbon spherulets is described in the European Patent Applications 118618 and 90073.

These test strips can be located with the adsorbents either outwardly or inwardly with respect to the emission source to trace out, for example in the latter case, cuts through a wallpaper exhibiting adsorption properties or through flooring materials exhibiting adsorption

properties. A strip of 20 mm x 100 mm, containing about 0.5 g of activated carbon, has proved to be very useful and handy. One embodiment consists of a double adhesive tape having one surface thereof loaded with adsorbent particles and the other surface covered with siliconized protective paper that has to be pulled off prior to use. The strip is packed in a gas-proof cover which protects the activated carbon until it is used and serves for the return delivery to the analytical laboratory. The strips can be applied, for example, on the bottom side of chairs, tables etc. by light pressure and can be easily removed therefrom.

A further application of these test strips is to control the decontamination of polluted buildings which will be illustrated by an example. As already described above, an all-over contamination of walls and ceilings by vaporization of PCBs in buildings made of prefabricated elements may occur, which can be neutralized by covering the contaminated surface by wallpaper containing activated carbon. In this case, it would be useful to foresee in good time an eventual escape of the PCBs through the wallpaper. To this end, the test strip with the adsorbent particles pointing towards the wall is pasted on the surface of the adsorbent wallpaper. When doing so, an adhesive tape overlapping the test strip is preferably used (1 cm overlap on all sides) such that the adsorption layer is not in contact with the adhesive. The surface facing towards the interior or the room can additionally be provided with a barrier layer, for example, an aluminium

foil, in order to increase the efficiency of the strip.

In respect of decontamination of a flooring or flooring material, a layer or a material that can absorb the odorants and the harmful manner, is laid between the contaminated flooring or flooring material and the new carpet or any other new flooring material. To carry out this method, granular or spherical adsorbents, preferably activated carbon, but also porous polymers, are, for example, caused to adhere on a flexible support material by means of an adhesive composition printed in a punctiform fashion and are covered with a slightly air-permeable textile material. A flat support material containing activated carbon that is suitable is described in European Patent Application 118618 and European Patent Application 90073.

A further possibility is to provide the support with a coating previous to water vapour which acts as adhesive composition for the adsorbents. The adsorbents are dusted into the coating; after drying, the layer of adsorbents is covered with a light textile fabric. By virtue of the all-over coating, an additional barrier layer is incorporated in addition to the adsorption layer, the barrier layer allowing the flooring to "breathe" due to its permeability to water vapour. The use of an adsorbent which is not part of the carpeting, allows subsequently laying of any kind of carpeting on the material. The adsorbents may also be directly applied on the carpeting. To do so, it is necessary to provide a high-quality backside coating which

serves at the same time as an adhesive composition for the adsorbents. This backside coating can additionally be covered by a light textile fabric. If this method is adopted, the accessibility of the adsorbents is at least 50%, preferably between 70% to 80%. This is advantageous in so far as the adsorption kinetics are concerned since a migration through the adhesive layer does not take place. In comparison thereto, activated carbon which, for example, may be incorporated into a backside coating in the form of a powder is less efficient because of the reduced accessibility of the outer surface.

In a further embodiment the material containing the adsorbent particles is a composite material consisting of a support layer of a flat-shaped support material selected from the group consisting of paper, wallpaper or textile fabrics, such as woven fabrics, knitted fabrics, non-woven fabrics or glass cloth; a layer located on said support layer and containing the adsorbent particles; and a cover layer applied on said layer containing the adsorbent particles. Thus, this composite material has a sandwich structure comprised of support layer, adsorbent particles and cover layer. The adsorbent particles are preferably applied on the support layer by means of a preparation containing an adhesive composition. The adhesive composition consists of organic binding agents, in particular a dispersion of plastic material or a low-solvent two-component system, or is selected from the group of latexes, for example, natural latex. This preparation

which contains the adhesive composition can either be applied in a punctiform or as all-over coating. For constructional physical reasons, the water-and air-permeability of the materials used plays an important role, so the adhesive composition should be permeable to water vapour, in particular if the coating is applied all over the surface.

A suitable cover layer for the materials that can be utilized in the method is formed of flat support material selected from the group consisting of paper, wallpaper or textile fabrics, such as woven fabrics, knitted fabrics, non-woven fabrics or glass cloth. This cover layer can preferably be laminated on the material containing the adsorbent particles by fusion adhesive-points or a thin web of fusion adhesive.

One composite material that can be used may be prepared, for example, as follows: the support pointing towards the inner space (textile fabric, special paper or glass cloth) is provided with a water vapour-permeable all-over coating which is at the same time the adhesive for the granular or spherical adsorbents. The coating is dusted with the adsorbents prior to drying. The excess is sucked off. The adsorption layer is subsequently covered, for example, by a light textile to protect it from the adhesive material by means of which the composite material is adhered to the building element. Light-weight fine-meshed non-woven polyesters with a printed-on-fusion adhesive are particularly suitable covers.

The over-all coating has the important advantage that even if a loosely woven textile support is used, the latter can be coated preventing the wall paint from contaminating or damaging the adsorbents or otherwise impairing the accessibility of the pollutants being adsorbed thereon. Dispersions that are suitable for preparing water vapour-permeable coatings are, for example, the Plextols of Röhm GmbH, Darmstadt or Impranils or Impraperm types of Bayer AG.

Another possibility of protecting the adsorbent particles against the penetration of paint is the following structure: the support layer facing the emission source, for example pointing towards a polluted wall, and the adsorbers themselves are covered by an outer material, a fusion adhesive-slit film being used as adhesive coat between the adsorbers and the outer material. This ensures that sufficient moisture can penetrate, but not the paint. However, either low-solvent paints or solvent-free paints should preferably be used for the coating.

In a further embodiment, an additional barrier layer, preferably a water vapour-permeable barrier layer, is located on the surface facing away from the emission source, i.e. on the support layer or the cover layer.

In a further embodiment of the adsorbent material, the surface of the material or composite material pointing towards the emission source, which may be the support or cover layer, is a separating layer designed to allow a removal of the composite material in such a manner that the



latter can be removed from the emission source and can be disposed of. Removal in this context means especially that the adsorbent particles connected with the separating layer can be removed, and completely so, from the emission source. This separating layer may preferably be a split paper or a split non-woven fabric or it may consist of two easily separable non-woven fabrics.

Tests have shown that in the case of adsorption of PCBs on activated carbon, due to the favourable adsorption equilibrium, the PCBs can be sucked off the emission source (for example a contaminated wall) such that the wall becomes almost free of PCBs within a few years. In this connection, the particular job of the separating layer is, for example, to allow simple stripping of a wallpaper from an emission source, so that the same can be disposed of in an appropriate manner, for example, by incineration of hazardous wastes. The PCB-containing adsorbents should be completely accessible and collected. To this end, a weak point (a predetermined breaking point) should be incorporated into the composite material of the support and the wallpaper. This possibility is offered by the following illustrative structure: textile outer material carries on the side thereof pointing towards the wall grains of adsorbents which adhere to the textile material by means of a discontinuously applied adhesive material. The adsorbents themselves are covered with a split paper. Split papers have a relatively well glued surface but are barely glued interiorly and are therefore splittable. When

they are pulled down, one half remains on the wall and can serve as base for a new wallpaper, while the other half continues to cover the adsorbents; thus a loss of adsorbents is completely avoided.

A further possibility of removing, for example, a wallpaper without a loss of adsorbents consists in making the cover of the adsorbents pointing towards the wall strong enough to resist breakage when the wallpaper is stripped. It is preferable to moisten the adhesive base first.

In general, an advantage of the above-described composite material is that the harmful matter can move freely within the adsorption layer until its adsorption. If due to a particular structure of the emission source, the liberation of harmful matter is more pronounced here and there, the latter can laterally expand freely in the adsorption layer due to the barrier layer and the sandwich structure (no local over-stress). A large amount of adsorbents is always available in all directions which allow a uniform distribution of the pollutants. If sealing is effected without applying any adsorbents, for example, with an aluminium foil, migration effects and massive escape will occur.

In contrast, small localised damage of the above described composite material, e.g., drilled holes, is completely harmless because the action of the adsorptive wallpaper, for example, is based on the bonding or capture of the pollutants in the neighbourhood of the emission

source and does not rely on an all-over insulation.

In a further embodiment the materials containing the adsorbent particles are present in the form of strips which, for example, are placed over joints sealed with a sealant containing the pollutant or are pressed into said joints. Preferably, these strips can themselves be covered with a material mentioned as suitable for the method, to ensure with absolute certainty that harmful matter does not escape into the room. Since, in general, the joint sealant is placed in a recessed position, there is enough room for a thick strip of adsorbent material; larger amounts of adsorbent particles can be accommodated in this cavity whereby safety can be guaranteed, even after many years.

The adsorbent particles which may be used are activated carbon powder, activated carbon spherules, activated carbon grains, carbonized and activated ion-exchangers, spherical pitch coal, hydrophobic molecular sieves, hydrophobic molecular sieve moldings or porous polymers. The adsorbent particles, in particular if activated carbon, may have an inner surface of at least  $90 \text{ m}^2/\text{g}$ . Activated carbon spherules and grains preferably have a diameter of from 0.1 mm to 2.0 mm, in particular from 0.3 mm to 1.0 mm. Preferably, the adsorbent particles are present in an amount of from  $5 \text{ g/m}^2$  to  $400 \text{ g/m}^2$ , in particular from  $10 \text{ g/m}^2$  to  $250 \text{ g/m}^2$ .

The manufacture of carbonized and activated ion-exchangers is described in German Patent Application 4304026. Suitable materials contain, in general, up to 70%

by weight of adsorbent particles.

Numerous methods lend themselves for applying the adsorbent particles, for example, on the support material. As described, for example, in German Patent Application 3211322, a paste comprising activated carbon and a binder dispersion is printed on in small deposits by means of a rotary screen-print; whereby coatings of up to  $100 \text{ g/m}^2$  can be obtained. The use of spherical activated carbon which is made to adhere to a textile fabric by a composition applied in a punctiform fashion is described in German Patent Application 3304349.

An adsorbent that is particularly suitable is spherical pitch coal. Thus, if spherical coal having a diameter of from 0.3 mm to 0.8 mm is used, up to 1000 spherules per  $\text{cm}^2$  can be applied on the support material of the test strips or the adsorbent material. This corresponds in practice to in excess of 20 mg/cm of accessible activated carbon since the adhesive composition closes only 10% of the pores. Spherical coal is particularly suitable having as it does an inner surface of from 1000 to 1200  $\text{m}^2/\text{g}$  and a micropore volume of 0.3 ml/g and a pore diameter of from 0.5 nm to 1.2 nm, basically from 0.8 nm to 0.9 nm. It is important that the micropores are relatively narrow to ensure maximum adsorption forces. On the other hand, the micropores must be large enough to be able to adsorb the pollutant molecules which are not small, for example, PCB molecules. Pore diameters of from 0.6 nm to 1.0 nm are therefore very advantageous. Pore

diameters of this kind are found, for example, in activated carbons based on pitch (spherical coal), based on coconut shell and based on specific hard coal. Pollutants are strongly adsorbed in these materials and are firmly held therein.

A homogenous loading of the support layer containing the adsorbent particles is important for the efficiency of the composite material. This is guaranteed especially if spherical activated carbon is used.

In addition to spherical coal, granular coal or salty coal (having a particle size of from 0.3 mm to 2.0mm) can basically be used. However, spherical coal is preferred due to its smooth abrasion-resistant surface and the optimum adsorption achieved therewith.

To adsorb specific pollutants, it may prove necessary to impregnate the adsorbent particles and/or to use various kinds of adsorbent particles: for example, pure activated carbon for pollutants having a high boiling point, for example, PCBs and PCPs; pure activated carbon, preferably with very small micropores, for solvents; activated coal impregnated with acid, for example, phosphoric acid, to adsorb ammonia and amines; activated carbon impregnated with a base, for example potassium carbonate, for acidic gases; coal impregnated with 2-amino-1,3-propanediol to absorb formaldehyde; sulfur-impregnated coal to adsorb mercury vapours; copper salts-impregnated activated coal to adsorb sulfur-containing and nitrogen-containing pollutants; to mention only the most important.

With regard to the escape of ammonia from a walling, it has proved particularly efficient to apply wallpaper containing phosphoric acid-impregnated activated carbon particles. The wallpaper may have basically the above-described sandwich structure: granular and spherical adsorbents being placed between two flat sheets of textile or paper, one being the support layer for the adsorbents and the other the cover layer for the adsorbents. To adsorb pollutants having a high boiling point, porous polymers, such as the XUS resins of the DOW Chemical company, can also be employed. Likewise to be recommended are carbonized and activated cation exchangers, comprising mainly sulfonated styrene/divinyl benzene-copolymers, which are very similar to the activated carbon in respect of their physical properties.

At least 50%, in particular between 75% and 80%, of the outer surface of the adsorbent particles should preferably be accessible to the pollutants and the adherents.

The emission sources which may be decontaminated with the materials of the present invention are in particular, building elements and building materials containing adherents and harmful matter, such as, for example, walls, bearing elements, prefabricated walls, concrete slabs, floors, ceilings, wooden beams, wooden floors, joints, sealants, primers and joint sealants.

Harmful matter in the sense of this application includes pollutants that can be adsorbed in particular on

activated carbon powder, activated carbon spherule, activated carbon grains, carbonized and activated ion-exchangers, spherical pitch coal, hydrophobic molecular sieves, hydrophobic molecular sieve moldings, and/or porous polymers. Pollutants belonging to this class are in particular polychlorinated phenols (PAP), polychlorinated biphenyl (PC), chlorinated hydrocarbons (CEO), polycondensed aromatic compounds (PAK), chloroparaffins, phthalates, amines, 2-ethylhexanol, ammonia and radon.

The invention will now be further described by way of the following Examples:

#### Example 1

The inner walls of a building built with prefabricated elements which were contaminated by being exposed for many years to PC-polluted ambient air, were coated all-over with a dispersion adhesive for heavy-weight wallpaper. A filter sheet material as taught in European Patent Application 118618, consisting of a glass fabric wallpaper loaded on one surface thereof with about 210 g/m<sup>2</sup> of activated carbon spherulets having a diameter of 0.5 mm with the aid of punctiformly applied adhesive material and covered with knitted textile fabric, was embedded in an adhesive bed. After conducting these measures, the PC concentration in the ambient air was reduced from about 10,000 ng/m<sup>3</sup> to below 300 ng/m<sup>3</sup> and remained thereafter under this value. The material gave the impression of a textile.

#### Example 2

The adsorbent particle containing material comprised

noise prevention slabs which were loaded at the surface facing towards the wall with granular activated carbon having a diameter of 0.55 mm to 1.2 mm and a bearing weight of 190 g/m<sup>2</sup>. The further process steps were the same as in the preceding Example. By virtue of the over-all covering, the PCB concentration could likewise be reduced to below 300 ng/m<sup>3</sup>.

#### Example 3

As cover material, a carpet covering the entire floor, the back-side of which was loaded with activated carbon spherules, was fixed to a PCB-contaminated concrete floor. The escape of PCBs could be completely prevented.

#### Example 4

A polyester fabric web having a basis weight of about 100 g/m<sup>2</sup> on which were adhered about 200 g/m<sup>2</sup> of spherical coal (average diameter: 0.55 mm) was cut into strips which overlapped the joints to be covered on both sides by 1.5 cm. The strips were fastened by adhesive tapes whereon the wallpaper was located, which for its part, was loaded with 200 g/m<sup>2</sup> of spherical coal.

#### Example 5

Siliconized protective paper was divided into three parts on an adhesive tape having a width of 10 cm namely into strips having a width of 7 cm, middle, and left and right strips of 1.5 cm respectively (1.5 cm + 7.0 cm + 1.5 cm = 10 cm). The middle strip of protective paper was progressively pulled off, and the adhesive layer with the spherical coal of Example 4 was simultaneously dusted



thereon, which adhered at once. The strip loaded with spherical coal could be rolled up without any problem. The lateral protective papers were pulled off at the place of operation and the strips were applied in such a manner that the coal layer overlapped the joint by about 1.5 cm. Wallpaper was laid on this strip as in Example 4.

#### Example 6

A web of a reticulated large-pored PU foam having a width of 1 cm (weight per litre 30 g, porosity 15 ppi) was thoroughly loaded with an adhesive material (Impranil HS 62 + Imprafix HSC, 30 g/l). 200 g of spherical coal/1 foam material were subsequently charged in a vibrator. After removing the excess and thermal curing of the adhesive composition, the web was cut into strips having a width of 4.5 cm and the latter were pressed into the joints having a width of 4 cm. The strips were fixed with an adhesive tape as fixing device. Wallpaper was placed over these strips as in Examples 4 and 5.

#### Example 7

PU foam, as used in Example 6, was loaded with a paste consisting of ground activated carbon, water and binder dispersion and was freed from excess paste in a squeezer. After drying the fabric web, the latter was cut into strips and further processed as indicated in Example 6. A typical paste preparation is as follows:

activated carbon:	315 g	(dry)
water:	435 g	
acrylate binder A (soft):	40 g	
acrylate binder B (hard):	80 g	
thickening agent solution (4% in water):	100 g	
lubricant (based on polyamide):	25 g	

The methods described in Examples 4 and 7 were applied to decontaminate PCB-polluted sealants in buildings made of prefabricated elements. Following application according to the Examples, no PCBs could be detected at the outer surface of the cover.

Analogous tests on a laboratory scale have shown that as described in the Examples, hydrophobic molecular sieves can be used instead of activated carbon.

As shown in the foregoing Examples, emissions of pollutants, such as PCBs can be significantly suppressed by the method of the present invention and may also be completely inhibited. As compared to the prior art passive collectors, the method of the invention allows practically 100% direct adsorption of harmful material diffusion from an emission source. In particular, pollutants having a high boiling point are permanently fixed. Tests have shown that pollutants in an amount of up to 10% by weight, based on the adsorbent particles, are fully absorbed. Thus, a coal amount of 200 g/m<sup>2</sup> can durably render harmless up to 20 g/m<sup>2</sup> of pollutant. Since such amounts never occur in practice, the activated carbon is never exhausted.

CLAIMS

1. Adsorbent material comprising a flat support material which forms a water-vapour permeable barrier layer and a layer located on said support material, containing adsorbent particles.

2. Adsorbent material comprising a layer of flat support material, a water-vapour permeable barrier layer located on said support material and a layer containing adsorbent particles deposited on said barrier layer.

3. Adsorbent material according to either Claim 2 or Claim 3, characterized in that it contains an additional cover layer deposited on said layer containing the adsorbent particles.

4. Adsorbent material according to any preceding Claim, characterized in that the support material is selected from paper, wallpaper or textile fabrics.

5. Adsorbent material according to any preceding Claim, characterized in that the barrier layer is an adhesive for the adsorbent particles.

6. Adsorbent material according to any preceding Claim, characterized in that the barrier layer consists of a slit film laminated on one side on the inner surface of the outer layer of the adsorbent material and connected to

the adsorbent particles on the other side.

7. Adsorbent material according to any of Claims 1 to 5, characterized in that the barrier layer consists of a fusion adhesive-slit film laminated on one side on the inner surface of the outer layer of the adsorbent material and connected to the adsorbent particles on the other side

8. Adsorbent material according to any preceding Claim, characterized in that the barrier layer is a latex coating applied on the surface of the adsorbent material which in use is outermost.

9. Adsorbent material according to any preceding Claim, characterized in that the adsorbent particles are activated carbon, activated carbon spherulets, activated carbon grains, carbonized and activated ion-exchangers, spherical pitch coal, hydrophobic molecular sieves, hydrophobic molecular sieve moldings or porous polymers.

10. Adsorbent material according to Claim 9, characterized in that the activated particles comprise activated carbon having an inner surface of at least 900 m<sup>2</sup>/g.

11. Adsorbent material according to either Claim 9 or Claim 10, characterized in that the activated particles comprise activated carbon spherulets and activated carbon

grains with a diameter of from 0.1 to 2.0 mm.

12. Adsorbent material according to either Claim 9 or Claim 10, characterized in that the activated particles comprise activated carbon spherulets and activated carbon grains with a diameter of from 0.3 to 1.0 mm.

13. Adsorbent material according to any of Claims 9 to 12, characterized in that the adsorbent particles are impregnated, preferably with phosphoric acid, potassium carbonate, trimethanol amine, 2-amino-1,3-propanediol, sulfur or copper salts.

14. Adsorbent material according to any of Claims 9 to 12, characterized in that the adsorbent particles are present in an amount of from 5 to 400 g/m<sup>2</sup>.

15. Adsorbent material according to any of Claims 9 to 13, characterized in that the adsorbent particles are present in an amount of from 10 to 250 g/m<sup>2</sup>.

16. Adsorbent material according to Claim 3 or any one of Claims 4 to 15 as dependant on Claim 3, characterized in that the cover-layer is formed from a flat support material selected from paper, wallpaper or textile fabrics.

17. Adsorbent material according to Claim 3 or any

one of Claims 4 to 15 as dependant on Claim 3 or Claim 16, characterized in that the cover layer is laminated on the layer containing the adsorbent particles by means of adhesive points or a web of fusion adhesive.

18. Adsorbent material according to any preceding Claim, characterized in that the surface of the material which, in use, faces an emission source is a separating layer allowing the removal of the adsorbent material from the emission source and the disposal thereof.

19. Adsorbent material according to Claim 18, characterized in that the separating layer is a split paper, split non-woven or consists of two easily separable non-woven fabrics.

20. Adsorbent material as claimed in either Claim 1 or Claim 2 and substantially as hereinbefore described.

## AMENDMENTS TO THE CLAIMS HAVE BEEN FILED AS FOLLOWS

CLAIMS

1. Adsorbent material for adsorbing odorants and/or pollutants emitted by an emission source comprising a flat support material which forms a water-vapour permeable barrier layer and a layer located on said support material, containing adsorbent particles, wherein the barrier layer is between the material's outer surface and the adsorbent containing layer and, in use, the material's inner surface faces the emission source.
2. Adsorbent material for adsorbing odorants and/or pollutants emitted by an emission source comprising a layer of flat support material, a water-vapour permeable barrier layer and a layer containing adsorbent particles, wherein the barrier layer is between the material's outer surface and the adsorbent containing layer and, in use, the material's inner surface faces the emission source.
3. Adsorbent material as claimed in Claim 2 wherein the a water-vapour permeable barrier layer is located on said support material and the layer containing adsorbent particle is deposited on said barrier layer.
4. Adsorbent material according to any preceding claim, characterized in that it contains an additional

cover layer deposited on said layer containing the adsorbent particles.

5. Adsorbent material according to any preceding Claim, characterized in that the support material is selected from paper, wallpaper or textile fabrics.

6. Adsorbent material according to any preceding Claim, characterized in that the barrier layer is an adhesive for the adsorbent particles.

7. Adsorbent material according to any one of Claims 1 to 5, characterized in that the barrier layer consists of a slit film laminated on one side on the inner surface of the outer layer of the adsorbent material and connected to the adsorbent particles on the other side.

8. Adsorbent material according to any of Claims 1 to 5, characterized in that the barrier layer consists of a fusion adhesive-slit film laminated on one side on the inner surface of the outer layer of the adsorbent material and connected to the adsorbent particles on the other side

9. Adsorbent material according to any one of Claims 1 to 5, characterized in that the barrier layer is a latex coating applied on the surface of the adsorbent material which in use is outermost.



10. Adsorbent material according to any preceding Claim, characterized in that the adsorbent particles are activated carbon, activated carbon spherulets, activated carbon grains, carbonized and activated ion-exchangers, spherical pitch coal, hydrophobic molecular sieves, hydrophobic molecular sieve moldings or porous polymers.

11. Adsorbent material according to Claim 10, characterized in that the activated particles comprise activated carbon having an inner surface of at least 900 m<sup>2</sup>/g.

12. Adsorbent material according to either Claim 10 or Claim 11, characterized in that the activated particles comprise activated carbon spherulets and activated carbon grains with a diameter of from 0.1 to 2.0 mm.

13. Adsorbent material according to either Claim 11 or Claim 12, characterized in that the activated particles comprise activated carbon spherulets and activated carbon grains with a diameter of from 0.3 to 1.0 mm.

14. Adsorbent material according to any of Claims 11 to 13, characterized in that the adsorbent particles are impregnated with phosphoric acid, potassium carbonate, trimethanol amine, 2-amino-1,3-propanediol, sulfur or copper salts.

15. Adsorbent material according to any of Claims 10 to 14, characterized in that the adsorbent particles are present in an amount of from 5 to 400 g/m<sup>2</sup>.
16. Adsorbent material according to any of Claims 10 to 14, characterized in that the adsorbent particles are present in an amount of from 10 to 250 g/m<sup>2</sup>.
17. Adsorbent material according to Claim 4 or any one of Claims 5 to 16 as dependant on Claim 4, characterized in that the cover-layer is formed from a flat support material selected from paper, wallpaper or textile fabrics.
18. Adsorbent material according to Claim 4 or any one of Claims 5 to 16 as dependant on Claim 4 or Claim 17, characterized in that the cover layer is laminated on the layer containing the adsorbent particles by means of adhesive points or a web of fusion adhesive.
19. Adsorbent material according to any preceding Claim, characterized in that the surface of the material which, in use, faces the emission source is a separating layer allowing the removal of the adsorbent material from the emission source and the disposal thereof.
20. Adsorbent material according to Claim 19, characterized in that the separating layer is a split

paper, split non-woven or consists of two easily separable non-woven fabrics.

21            Adsorbent material as claimed in either Claim 1 or Claim 2 and substantially as hereinbefore described.



Application No: GB 9805390.3  
Claims searched: 1--20

Examiner: Diane Davies  
Date of search: 2 April 1998

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): B2E: EM

Int Cl (Ed.6): A62D5/00; B32B 5/16, 29/02

Other: Online: EDOC, JAPIO, WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
X	EP 0465817 A (W.L. Gore & Assoc.) Whole document: absorbent layer attached to water-permeable fabric layer	1-21
X	EP 0304952 A (Personal Products Co.) Whole document: deodorant powder incorporated in a polymer layer which has a support layer of woven web, paper or film.	1-21
X	EP 0260841 A (Soreq Nuclear Research Centre) Whole document: absorbent layer attached to water-permeable fabric layer.	1-21
X	EP 0118618 A (H. von Blücher & E. de Ruiter) Whole document: waterproof and moisture conducting fabric with a coating containing activated carbon and other absorbents, see in particular page 9 lines 12-16.	1-21

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.



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36

Application No: GB 9805390.3  
Claims searched: 1--20

Examiner: Diane Davies  
Date of search: 2 April 1998

Category	Identity of document and relevant passage		Relevant to claims
X	US 4454191 A	(H. von Blücher & E. de Ruiter) Whole document: waterproof and moisture conducting fabric with a coating containing activated carbon and other absorbents	1-21
X	US 4554198 A	(H. von Blücher & E. de Ruiter) Whole document: waterproof and moisture conducting fabric with a coating containing activated carbon and other absorbents.	1-21
X	DE 3818993 A	(H. von Blücher & E. de Ruiter) Whole document: use of absorbent coatings to carpets and wall-hangings for pollution control.	1-21

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.